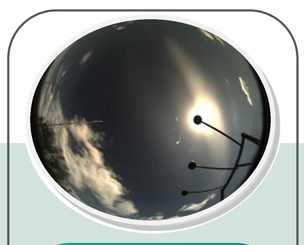
Optimized DNI forecast using combinations of nowcasting methods from the DNICast project

L. Ramírez [1], N. Hanrieder [2], L. F. Zarzalejo [1], T. Landelius [3], S.C. Müller [4], M. Schroedter-Homscheidt [5], S. Wilbert [2], J. Dubrana [6], J. Remund [4], R.X. Valenzuela [1], J.M. Vindel [1]

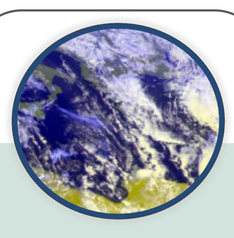
[1] CIEMAT, Madrid , Spain; [2] DLR, Tabernas , Spain, [3] SMHI, Norrköping, Sweden, [4] Meteotest, Bern, Switzerland, [5] DFD, Wessling, Germany, [6] ARMINES, Paris, France

Goals

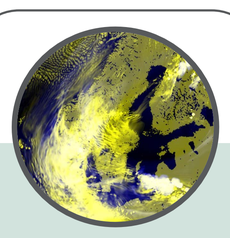
The *efficient* Operation of Concentrating Solar Technologies (CST) requires reliable forecasts of DNI



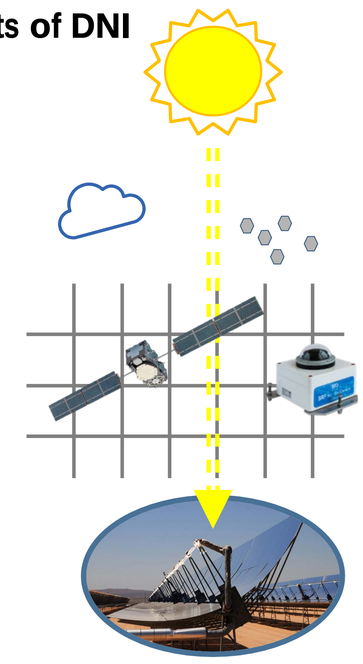
Ground-based Sky Imagers
intra-hour nowcasting:
0 – 15 min



Satellite based cloud and DNI nowcasting
intra-hour and intraday:
5 – 360 min



Numerical Weather Prediction
intra-hour and intraday:
60 – 360 min or more

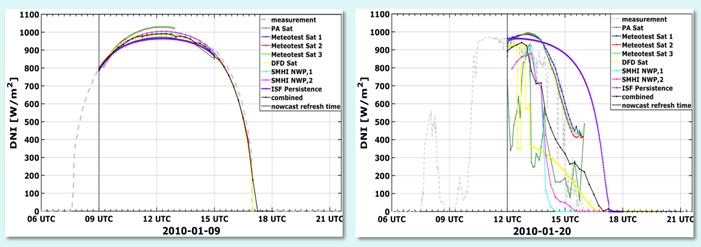


TECHNICAL ASPECTS

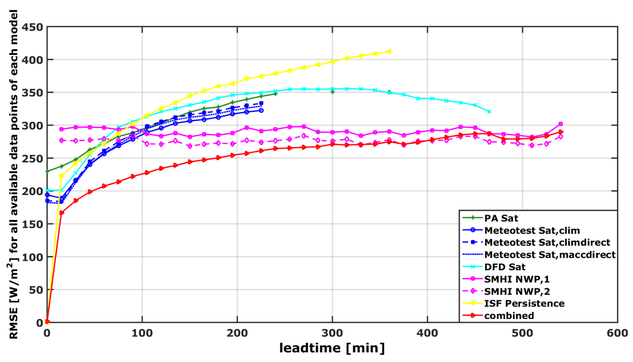
- **Three different methodologies for combining nowcast outputs.**
- **Nowcasting outputs tested at Plataforma Solar Almería - Spain.**
- **4 time periods:**
  - **Jan – Mar 2010**
  - **Mar – May 2013**
  - **Jul – Ago 2014**
  - **Sep – Nov 2015**

UWA
Uncertainty weighted based approach

- Uses ***uncertainty*** of input nowcasting data set.
- Includes **only available** data set.
- Combines several nowcasts by **weighting quality**



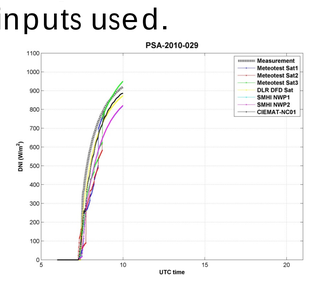
Including selected periods of 2010, 2013, 2014 and 2015

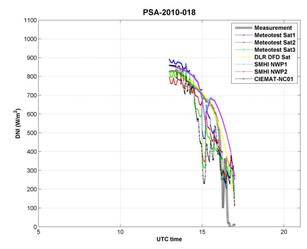


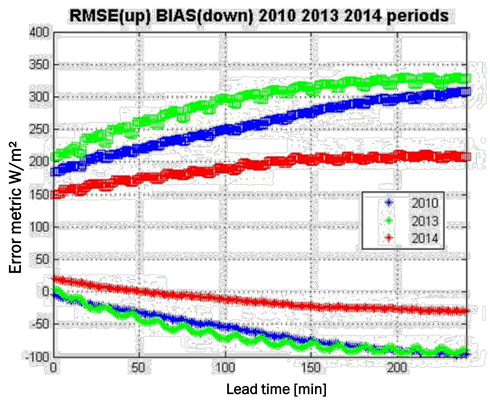
➢ RMSE of combined method decreases vs inputs forecasts for all lead times.

MRA
Multi-regressive approach

- Uses ***time-dependent*** multi-regressive model.
- Applies adaptive **linear merging**.
- DNI **predicted values** in previous forecast are the inputs used.



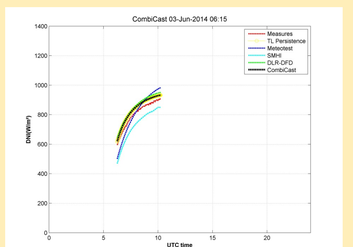


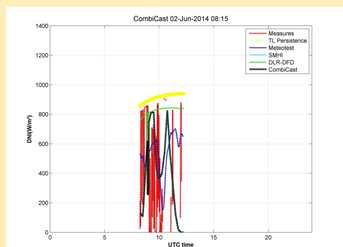


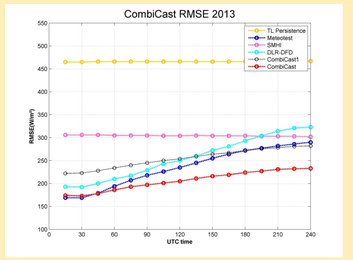
➢ RMSE decreases in clear periods

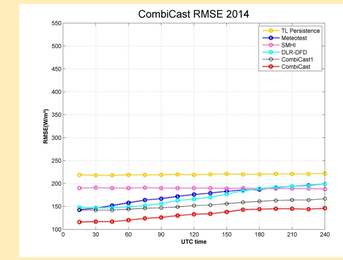
DWA
Distance weighted combination

- Uses ***the distance*** of previous measurements.
- Includes **only available** data set.
- **Weights** based in Euclidean distance and CoV comparisons.







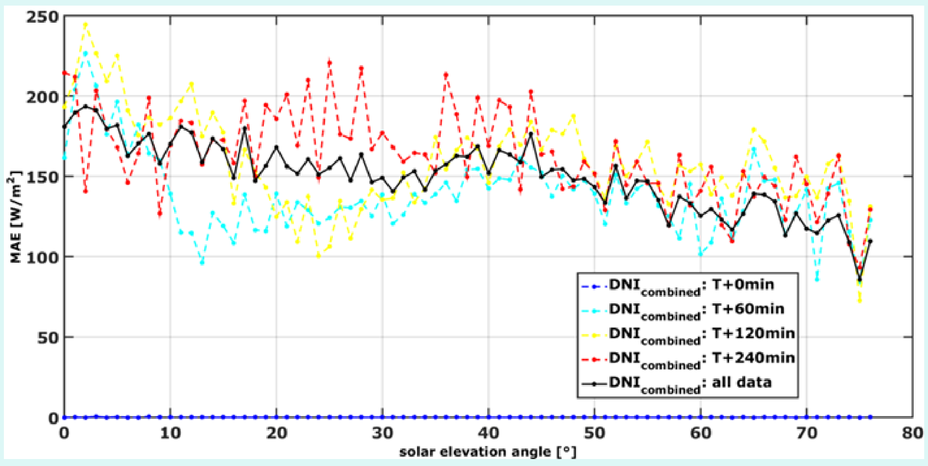


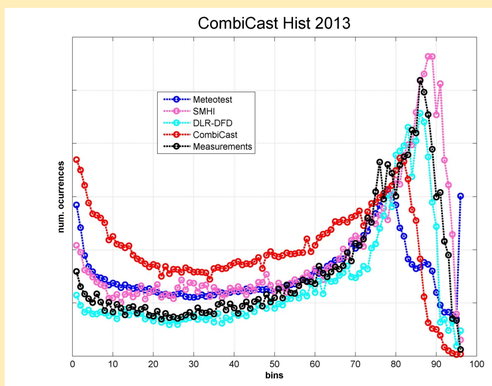
➢ Improvements using TL persistence from previous measurements.

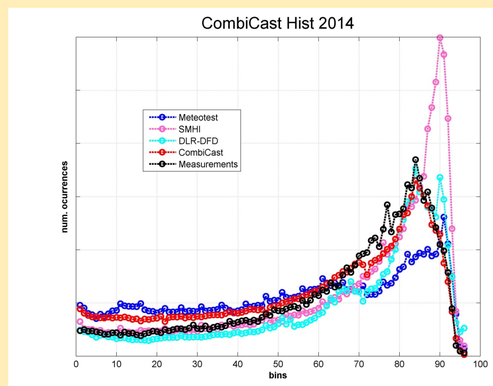
➢ RMSE of combined method decreases vs inputs forecasts for all lead times.

➢ Best results in clear periods both for inputs and combination.

- MAE is generally higher for smaller solar elevation angles and decreases for higher angles.
- This is valid for all lead times.
- The MAE is almost zero for all solar elevation angles and lead time 0 due to the included persistence nowcast.







GENERAL RESULTS

- **Lower errors** in combined nowcast than in single nowcasts.
- **Better results** in Summer periods: better coincidence in persistence and less clouds.
- **UWA** model is **simple** and **effective**.
- **Combined nowcast** used to **evaluate benefits** of power plant operation.

FURTHER COMMENTS

- **Conventional errors are not enough** for forecasting characterization.
- **Further dependences** have to be evaluated in solar radiation forecasting.
- **Probabilistic differences** on the variable behavior have to be addressed.
- **Improvements expected in future works** applying machine learning.

ACKNOWLEDGEMENTS

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